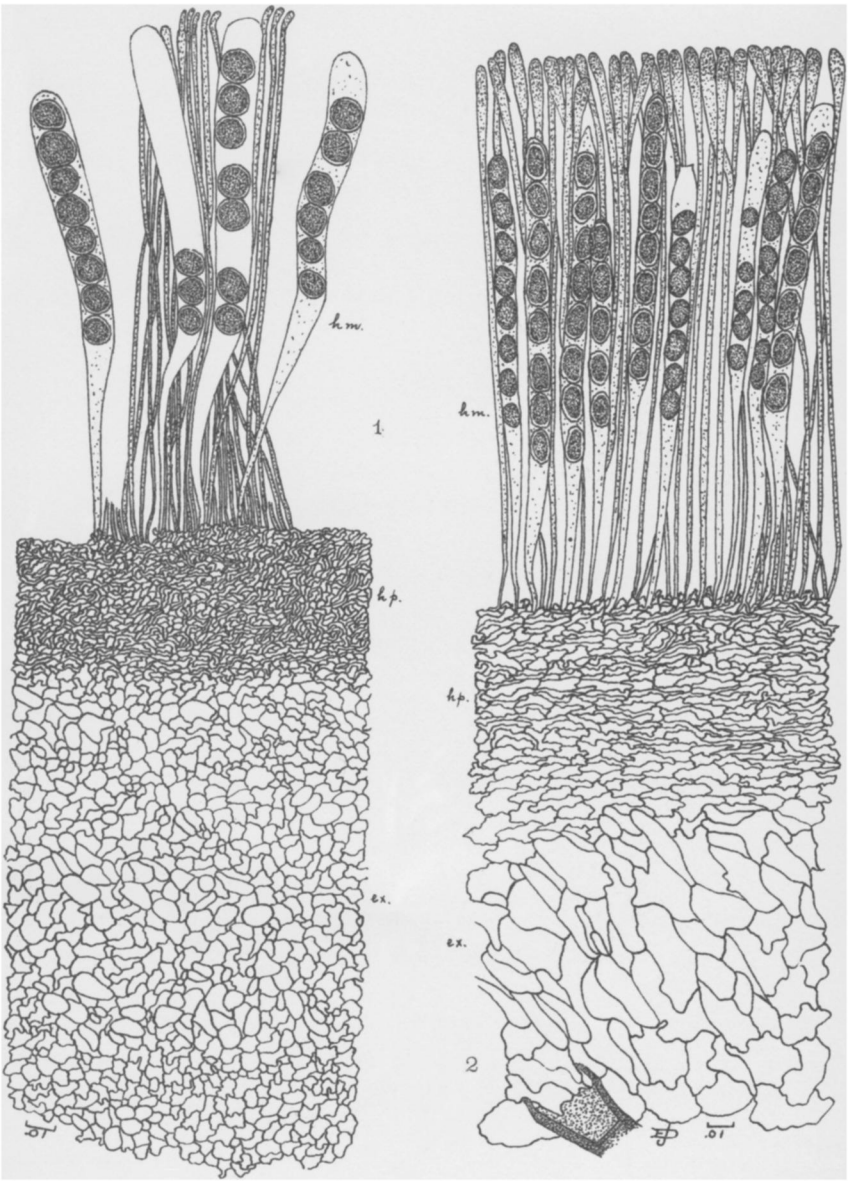

DURAND ON THE PEZIZINEAE.

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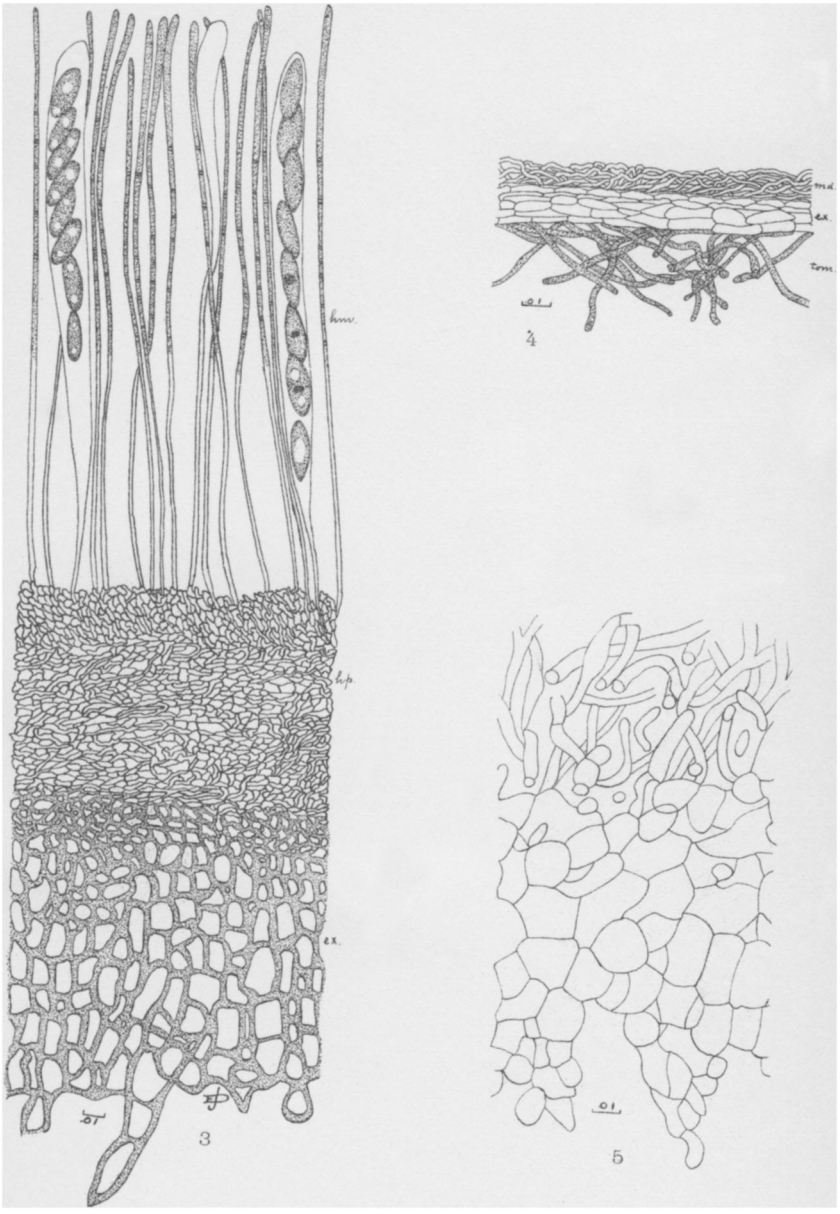

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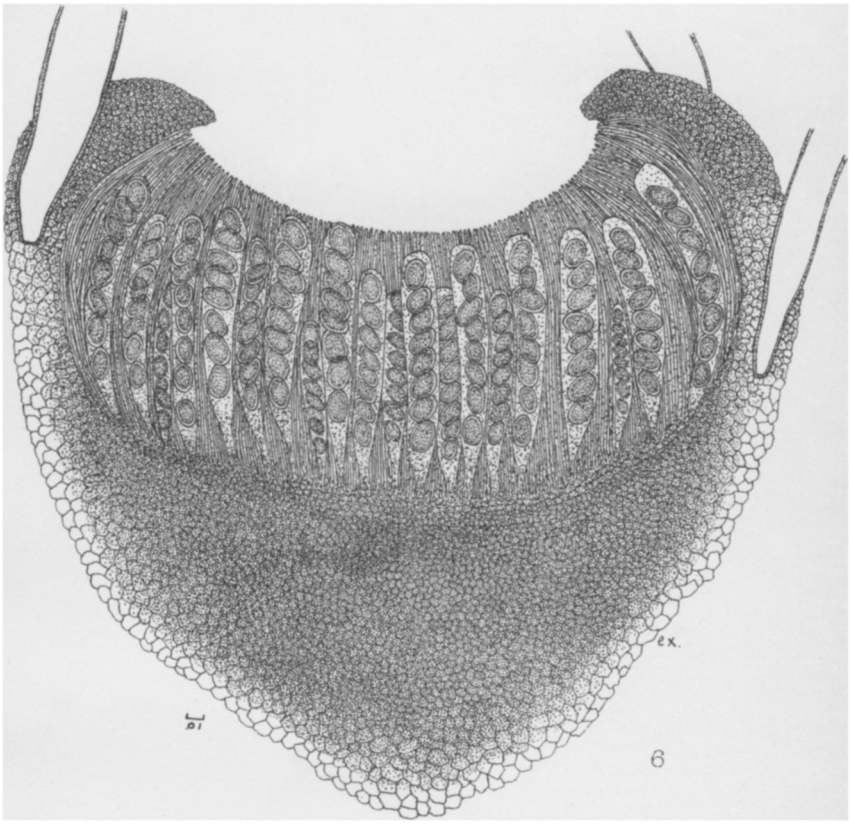

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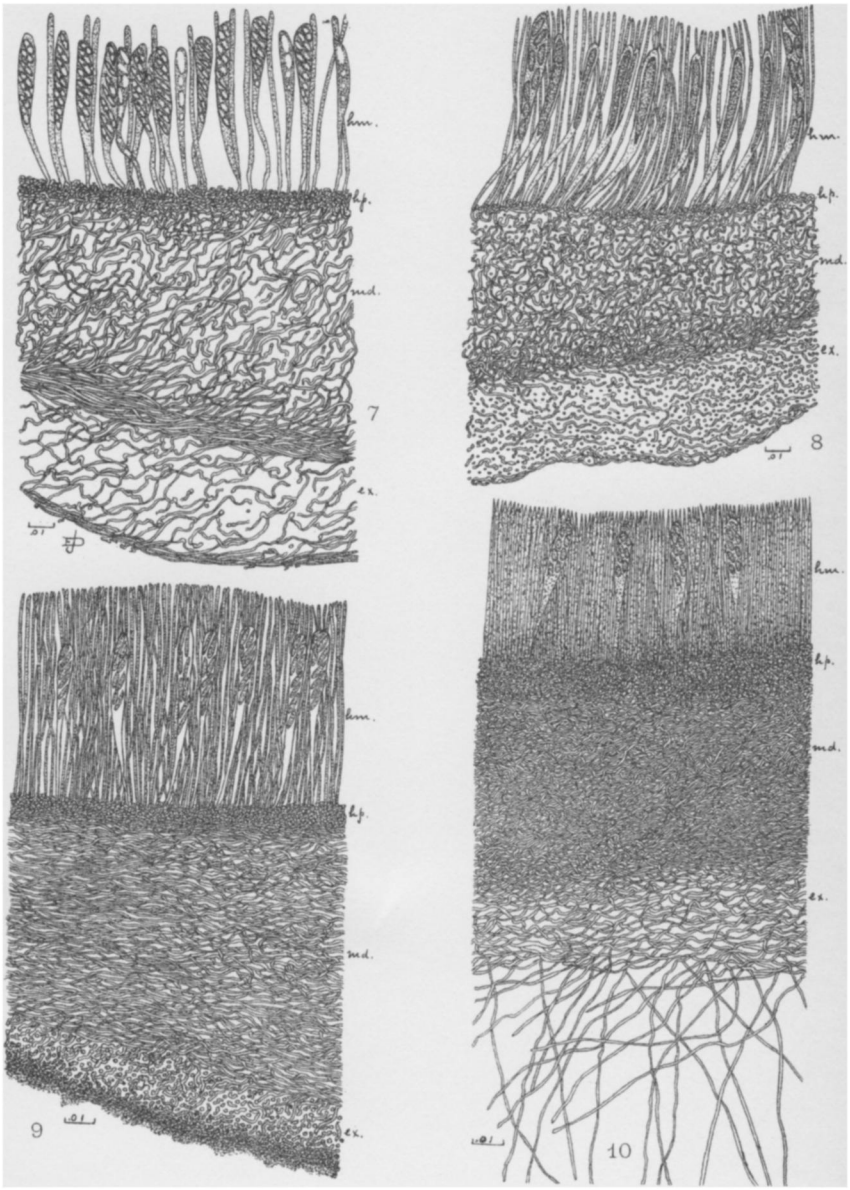

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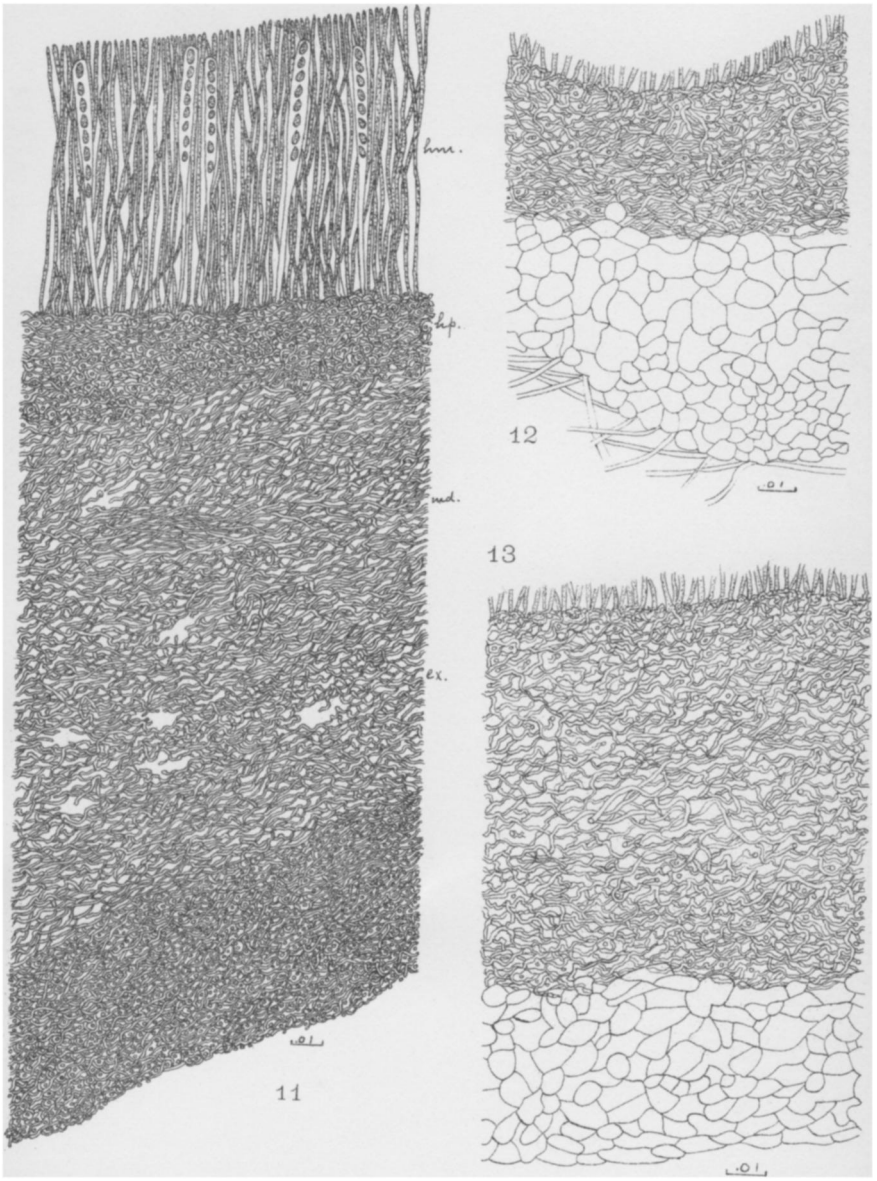

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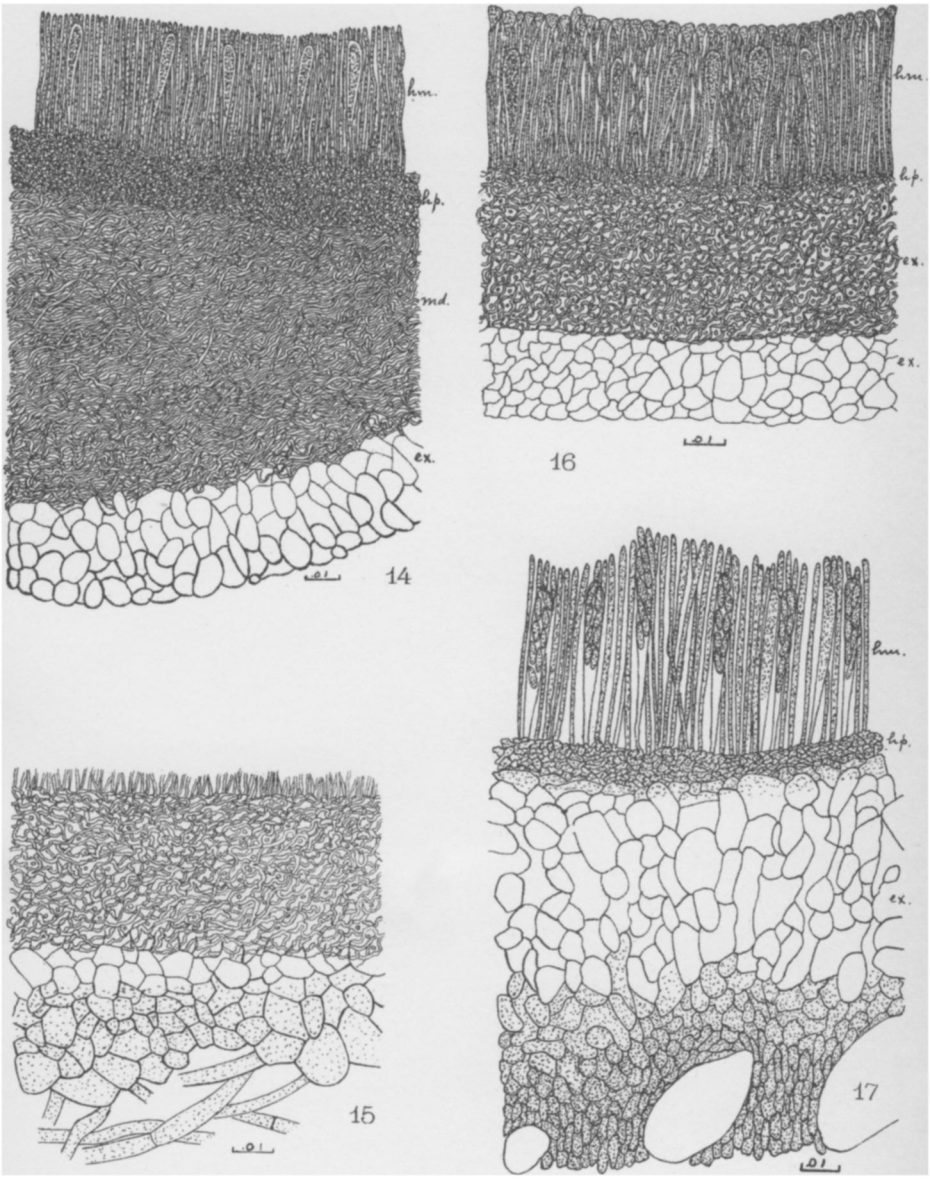

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The Classification of the Fleshy Pezizineae with Reference to the Structural Characters illustrating the Bases of their Division into Families*

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(WITH PLATES 27–32)

I. HISTORICAL

The classification of plants may be said to have passed through a course of development. In the early days, when the number of known species was small, they were included in comparatively few genera, although in many cases they were widely diversified in characters. As time went on and the number of described species increased, the limits of the genera were expanded until they included an exceedingly heterogeneous mass of forms. But as botanists turned their attention more and more to the arrangement of forms there became manifest the tendency to break up these heterogeneous groups into a number of smaller divisions. These large genera, as originally constituted are, in general, substantially equivalent to the ordinal and family groups of modern writers.

This mode of development is well illustrated in each of the great groups of the Ascomycetes. The genus *Sphaeria*, as understood by the earlier writers had practically the same limits as the order Pyrenomycetes of the modern systematists. In the course of time this genus was broken up into numerous genera which by later writers are included in several families.

*This paper was prepared under the direction of Professor George F. Atkinson whose kindness and assistance the writer wishes here to acknowledge.

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The development of the classification of the Discomycetes has been along similar lines. In 1719 Dillenius* described a genus of fungi under the name *Peziza*. The catalogue proper and the apppendix are paged separately, and on page 76 of the latter occurs the description in the following terms: "TAB. 1, PEZIZA vel ut *Plinius* habet PEZICA pediculo etiam utplurimum, pileo vero semper caret, et ex substantia homogenea membranacea, concava et aquam continere apta, tenera plerumque, aliquando tamen, ut in seminiferis, subdura constat. Pertinent enim Fungi illi calyciformes seminiferi ad Pezizas, et corpuscula illa lentiformia minime vera semina sunt." No species are mentioned in this connection, but in the catalogue proper, which is arranged by months in which the plants appear, several Pezizas are enumerated on pp. 194–196—in all, thirteen forms.

The name *Peziza* is a modification of the Latin word *Pezica*, which is itself borrowed from the Greek πέζικες or πέζεαι. *Pezica* was mentioned by Pliny† in the following terms: "Belonging to the mushroom kind, also, there is a species known to the Greeks by the name 'Pezica,' which grows without root or stalk." Whether Pliny's Pezica refers to any of the plants at present included under the Discomycetes, it is of course, impossible to determine.

Linnaeus in the Species Plantarum of 1753‡ adopted the genus *Peziza* in very nearly the sense of Dillenius, and described eight species. In the Systema §, also, he retained the genus in the same sense and enumerated several species.

In the Observationes Mycologicae 1796‖ Persoon described the genus *Peziza* with sixteen species, and *Ascobolus* with three species.

Practically the first attempt at systematic classification of the Pezizaceous plants was made by Persoon in his Synopsis, in 1801¶. In this work the cup-shaped Discomycetes were described under three genera: *Peziza*, *Ascobolus* and *Helotium*. The group of the Ascoboli is quite distinct and well defined, so that, however much systematists may have differed as to its relative rank, the autonomy of the group has been preserved in nearly all systems of arrangement. The genus thus early defined had practically the same

* Dillenius, appendix, p. 76.
† Pliny, 19, 3, 14 § 38.
‡ Linnaeus (1), p. 1180.
§ Linnaeus (2).
‖ Persoon (1), p. 26.
¶ Persoon (2), p. 631.

limits as the family Ascobolaceae of later authors. The genus *Helotium* as limited by Persoon included four unquestioned species, which were also typical species of the same genus as defined by Saccardo.*

The two genera *Ascobolus* and *Helotium* together contained only eight well defined species. All the other cup-shaped Discomycetes, of which he enumerated 151 species, Persoon relegated to the genus *Peziza*. This genus was defined as follows: "Receptacle hemispherical, concave, tumid, bearing fruit in a smooth disc. (Thecae sack-like, invisible to the naked eye, when mature with eight sporidia which are expelled like smoke)." *Peziza*, as thus defined, was broken up by the author into seven lettered sections, which were based on the consistency of the cup, together with its external characters. Of these seven sections only the first four need concern us, as being included within the limits of this paper.

The section A, Tremelloideae, included those forms in which the consistency of the cup is more or less tremelloid. Its limits were in general very nearly those of the family Bulgarieae of Saccardo. Section B comprehended all of the large, fleshy Pezizineae which are externally smooth or subfarinaceous. Section C was made up of those which are externally strigose, pilose, or pubescent, whether they be fleshy or waxy, while Section D included those which are fleshy-waxy and smooth.

Persoon's arrangement was to a certain degree a natural one, although founded upon the gross characters of the plants. I have gone thus far into the details of the system because it formed the basis of the Friesian system of classification which remained in almost universal use for seventy years.

The next step in the systematic arrangement of the Discomycetes was taken by Fries † in 1822. In his Systema Mycologicum there was established an order Elvellaceae, made up of two suborders Mitrati and Cupulati. The suborder Mitrati was formed to include the genera with mitrate or clavate apothecia, while the cup-shaped ones made up the Cupulati. The latter group was divided into three families (1) Pezizeae, (2) Dermeae, and (3) Heteroclitae. The family Pezizeae (omitting the genus *Patellaria*)

* Saccardo (2), p. 210. † Fries (1), 2: 35.

corresponded pretty nearly to Schroeter's order Pezizineae. It was also equivalent to the genera *Peziza* (exclusive of divisions A, E, F, and G), *Ascobolus* and *Helotium* of Persoon.

The family Pezizeae comprised three genera, exclusive of *Patellaria*. These were *Peziza*, *Ascobolus* and *Bulgaria*. *Ascobolus* was transferred intact from Persoon's system. *Bulgaria* was the same as the section A, Tremelloideae, of that author, while the genus *Peziza* of Fries comprised Persoon's *Peziza* sections B, C and D.

Fries divided his genus *Peziza* into three series, which were in turn separated into twelve tribes. The three series *Aleuria*, *Lachnea* and *Phialea*, thus constituted, were equivalent to the divisions B, C and D, respectively, of Persoon.

From what has been said in the paragraphs preceding, it will be seen that the Friesian classification was founded directly upon that of Persoon. Prominent points of difference are found in the narrowed generic limits of *Peziza*, as well as the fact that three families were constructed from the genus as limited by Persoon. The important fact to be noticed, however, is that Fries established ordinal, subordinal, and family grouping which did not exist in the nomenclature of the earlier writer. Persoon's *Peziza* was the suborder Cupulati of Fries. On the other hand the minor divisions of the two authors corresponded almost precisely.

The Friesian arrangement, then, will be recognized as an important step in the development of the classification of the Discomycetes. It is apparent, however, that the basis for this is to be found almost entirely in the gross and external characters of the plants. No peculiarities of development or of microscopic structure had at this time any place in systematic classification.

This system of classification remained in use for twenty seven years. In 1849, the same author * produced a modification of his previous arrangement, which will be recognized as a marked improvement in the system. There was established a family Discomycetes under which were included six orders, (1) Helvellaceae, (2) Bulgariaceae, (3) Dermateae, (4) Patellariaceae, (5) Phacidiaceae and (6) Sticteae.

The order Helvellaceae included besides the cup-shaped forms, the mitrate and clavate ones as well.

* Fries (2).

This establishment of numerous orders based largely on the consistency of the plant was an important step. No less significant was the still further narrowing of the generic limits of *Peziza*, and the consequent formation of new genera. The *Peziza* of the former arrangement was here separated into eight genera, of which the largest and most important were *Peziza* and *Helotium*. The genus *Peziza* was as before divided into three series, which were still further broken up into eleven tribes. How much Fries relied upon gross characters may be gathered from his own statement that it is not possible to base natural genera on either the form, septation, or markings of the spores.

The second Friesian system of classification remained in use for thirty years. M. C. Cooke followed it in nearly every detail in his publications from 1871 to 1879, as did also Karsten in his earlier publications.

From what has been said it will be seen that the classification of the Pezizineous Discomycetes advanced in a definite direction from 1801 till 1879, and that this period was marked by three important steps in the progress.

It will be remembered that within the decade between 1860 and 1870 a great change came over the aspect of mycological study. This was heralded by the publication of de Bary's Morphology and Physiology of the Fungi, Lichens and Myxomycetes, in 1866. The most of the work done before this time had been upon the external or gross parts of the plant, the microscopic structure being almost entirely neglected. At this period, however, the attention of students was being turned more to the structural details and to the development of plants, a kind of investigation which has laid the foundation for sounder systems of classification.

This influence was early felt in the study of the Discomycetes. In 1864, De Notaris treated the Discomycetes in a general way under twenty six genera, of which nine would be included in the fleshy group. These were thrown together without any apparent principle of arrangement. Microscopic characters such as the form and color of the asci, paraphyses and spores were made use of, but the measurements were given in but few instances. Another character which was occasionally used, especially in generic

descriptions, was drawn from the cell structure of the excipulum. Six genera were first described in this paper.

Nylander in 1868 followed the classification of Fries, enumerating 108 species of *Peziza* and 8 of *Ascobolus*. He was the first to describe accurately and fully the characters of the asci and spores and to give careful measurements. This author also laid much stress on the action of iodine in coloring the asci.

Karsten in 1869* divided the genus *Peziza* into 25 sections and described 239 species. This work is noteworthy in this connection principally as showing the tendency to break up the genus *Peziza* into subgenera.

Fuckel† in this same year defined a group Discomycetes, which he separated into six subgroups or families, as follows: Sticteae, Phacidiaceae, Patellariaceae, Bulgariaceae, Pezizeae, and Helvellaceae. These groups were based for the most part upon the Friesian arrangement. The most marked peculiarity of Fuckel's system is to be found in the closeness with which his generic limits were drawn. Under the Pezizeae were included thirty one genera, based upon the habit, consistency, color, external features, and the minute characters of the fruiting organs. The genera were grouped in the family on the basis of consistency.

Karsten‡ acknowledged his indebtedness to the labors of such men as Tulasne and de Bary, and adopted in his Mycologia Fennica of 1871 an arrangement in which their influence was manifested. In the work mentioned there was described an order, Discomycetes, including three families—the Helvellaceae, Pezizaceae, and Phacidiaceae. Under the Pezizaceae several subfamilies were described, of which some, notably the Pezizeae, Helotieae and Mollisieae, exhibited relationships which had not been indicated previously. A prominent character suggested in connection with these three families was taken from the structure of the cells of the sterile portion of the apothecium. In the arrangement of genera, Karsten discarded the Friesian system entirely. Many new genera were erected, but, in this respect, the present writer was much less radical than Fuckel.

During the few years following, no publication of importance appeared relating to the classification of the Discomycetes. To be

* Karsten (1). † Fuckel, p. 248. ‡ Karsten (2), p. 5.

sure, M. C. Cooke brought out the very excellent Mycographia or figures of the Discomycetes but the arrangement was that of Fries. In 1884, however, Saccardo,* in his Conspectus Discomycetum, applied to these plants the novel method of arrangement which he had already made use of in other groups of the Ascomycetes. He adopted an order Discomycetes, including eight families. Within the families the subdivisions were based on the color, form and degree of septation of the sporidia. Saccardo's generic limits occupied a middle ground between those of Fries, on the one hand, and of Fuckel and Karsten on the other. There were a few large genera with large numbers of subgenera.

Phillips, in 1887, adopted the major groups set forth by Saccardo, including, however, a ninth family, the Gymnoascaceae, with a single genus *Ascomyces* (*Exoascus*). The group Pezizeae was separated into two series, Nudae and Vestitae, based on the external features of the cup. Under these were arranged twelve genera, most of the species, however, being included under five of these, which in turn contained numerous subgenera, many of which had been given generic rank by Fuckel and Karsten.

In 1889, appeared the volume of Saccardo's Sylloge Fungorum† treating of the Discomycetes. The arrangement here used was based on the Conspectus of 1884. Generic limits were, however, much more closely drawn in the Sylloge than in the earlier work, the old Friesian arrangement was entirely abandoned, and most of the subgenera of the Conspectus were elevated to generic rank, while several new ones were added.

M. C. Cooke,‡ in 1892, abandoned the Friesian system, adopting as the best yet produced the arrangement of Saccardo's Sylloge Fungorum. He, however, dispensed with the grouping based on the color of sporidia, making a subsequent slight rearrangement of the genera.

During the last dozen years there have appeared three important German works dealing with the Discomycetes. In 1887, Rehm began to elaborate the Discomycetes for Rabenhorst's Kryptogamen-Flora. The most striking innovation in this work was the inclusion of many of the Lichens among the Discomycetes. The order was separated into two divisions: (1)

* Saccardo (1). † Saccardo (2). ‡ Cooke (3), pp. xiii, 249 et seq.

Pezizaceae and (2) Helvellaceae. The Pezizaceae were broken up into five suborders: Phacidiaceae, Stictideae, Triblideae, Dermatiaceae and Pezizeae. The Lichens were distributed among the first three or four of these suborders, while the Bulgariaceae were included as a family under the Dermatiaceae. In subdividing the Pezizeae, Rehm elaborated the principle outlined by Karsten in giving prominence to the characters drawn from the sterile layers of the cup. The suborder was made to include four families: Mollisiaceae, Helotiaceae, Eupezizeae and Ascobolaceae. Rehm's generic limits were, in general, those of Fuckel and Saccardo.

Schröter, ‡ in 1893, followed Rehm for the most part, but differed from him in including the Taphrinineae and Hysteriineae under the Discomycetes. The families of the Pezizineae corresponded to those of the Pezizeae of Rehm, except that a fifth family was formed to include the genera *Ascodesmis* and *Ascocalathium*. Another arrangement of some novelty adopted by Schröter was the distribution in the Pezizineae of several genera formerly included with the Bulgariaceae.

In 1894, in writing the Discomycetes for Engler and Prantl, Schröter § departed somewhat from his arrangement of 1893 in that he included under the Pezizineae ten families of coördinate rank. Unfortunately, Schröter's work was cut short by death when it was but just begun. It was continued along similar lines by Lindau, by whom it was recently brought to completion.

II. MORPHOLOGICAL

Limits of the Paper.—The discussion in this paper is confined to Schröter's* subdivision Pezizineae, exclusive of the family Ascodesmidaceae. The group thus limited is equivalent to Rehm's† suborder Pezizeae, also to the families Pyronemaceae (in part), Pezizaceae, Ascobolaceae, Helotiaceae and Mollisiaceae treated by Schröter and Lindau in Engler and Prantl's Natürlichen Pflanzenfamilien. The examination is intended to cover all of the cup-shaped Discomycetes which are fleshy or waxy.

Technique.—The material on which the study and illustrations are based is mostly American. Much of it was taken from the

* Schröter (1), p. 1.
† Schröter (2), p. 173.
‡ Schröter (1), p. 31.
§ P. 501 et seq.

specimens in the Ellis and Everhart collection of North American Fungi. Some forms were obtained from Rabenhorst's Fungi Europaei, and from Roumeguère's Fungi Gallici. The remainder was found in the vicinity of Ithaca or was obtained from correspondents in various parts of the country. Most of the material was fresh or preserved in liquids. This was true of nearly all of the Pezizaceae. The tissues of the Helotiaceae and Mollisiaceae do not seem to be injured by drying. Such material, after being soaked in water, was dehydrated and imbedded in collodion. This method of imbedding is well adapted to work of this kind.

The sections, varying from 6 μ to 20 μ in thickness, were taken from near the base of the cup. The stipitate forms were cut longitudinally through the middle of the stem and cup.

Various stains were used, but alum eosin, acid fuchsin and Delafield's haematoxylin gave the best results.

Terms Employed.—The terms employed in this paper are those proposed and defined by de Bary.* The term apothecium is applied to the whole sporocarp. It consists of two principal portions. The fruiting layer or hymenium, and the sterile layers beneath or partially surrounding the fertile part. The stratum of hyphal tissue immediately beneath the hymenium is the hypothecium. Grading off from the hypothecium is an often more prominent and well-differentiated outer layer, the excipulum. Frequently two layers may be distinguished in the latter portion. The outer one, being usually more dense, forms a sort of membranous ectal layer of the apothecium, and encloses a medullary portion within.

The term pseudo-parenchyma is applied to the parenchyma-like tissue formed by the septation and coalescence of hyphae. All gradations between true hyphae and the pseudo-parenchyma may often be seen in a single plant. Prosenchyma is a tissue composed of long, slender, interwoven hyphae.

The several layers of the sterile portion of the apothecium are usually not strongly differentiated, but often grade almost imperceptibly into one another. It is upon the structure of the sterile layers of the apothecium that the division into families has been

* De Bary (2), p. 187.

largely based. In the following pages numerous examples will be studied in order to determine what characters may be safely used as bases for such family grouping.

Family PEZIZACEAE

DISCINA STEPHENSONIANA Ell.

This species grows on rotten wood. The plants are usually crowded and irregular with a short, fleshy stem. The cups are 3–8 cm. in diameter, with a flat or concave disk, and a recurved or laciniate margin. The flesh is light cinnamon brown, but whitish beneath.

This is a very interesting plant as far as the structure of its sterile layers is concerned. Beginning at the lower surface there appears first a layer of pseudo-parenchyma composed of very small thin-walled, polygonal cells. They average about 6–8 μ in diameter. Just above this layer is one of about equal thickness, composed of quite large, polygonal, isodiametric cells 30 μ in diameter. These cells show little or no trace of their hyphal origin. Joining this layer with an abrupt transition is a rather thin one of coarse hyphae, with frequent septa. Septation and coalescence have not advanced so far in these threads that the hyphal form is lost.

The transition from hyphae to pseudo-parenchyma is very nicely shown in the thick layer just above the hyphal one last described. The tissue is composed of stout hyphae loosely interwoven with large interhyphal spaces. These hyphae are much septated, and often coalesce, thus giving rise to many polygonal cells measuring from 15 to 90 μ in diameter. The thin layer immediately beneath the hymenium is composed of similar cells, among which the asci may be traced down for some distance.

DISCINA WARNEI Peck

The sterile layers in this species are composed throughout of very coarse hyphae which are much bent and septated so as to resemble a pseudo-parenchymatous tissue. In the looser portions individual threads may be traced for some distance. In these, certain portions are seen to be much swollen so as to be almost vesic-

ulose. At other places the threads are thin and narrow and coalesced with other hyphae. In all cases the hyphal nature is evident. The whole tissue resembles closely that found in certain layers of the last species described.

ACETABULA VULGARIS Fuckel

The Acetabulas are cup-shaped, fleshy plants, provided with a short, thick stalk, the surface of which is marked by longitudinal ridges, which branch more or less, and continue on the lower surface of the cup.

The sterile portion of *A. vulgaris* is differentiated into three well marked regions. The hypothecium is about 75 μ thick and composed of a pseudo-parenchyma of small, rounded cells, 6–12 μ in diameter. A medullary portion occupying about two thirds of the remaining thickness is made up of coarse hyphae rather loosely interwoven. This grades off into the hypothecium above and the cortical layer below. The latter is pseudo-parenchymatous, being composed of cells 50–75 μ in diameter with thin walls, and more or less elongated toward the surface, where some are prolonged, giving to the exterior a scurfy appearance.

GEOPYXIS CUPULARIS L.

The genus *Geoypxis* resembles *Acetabula*, but differs from it in having the stem smooth. In the species under consideration the excipulum is quite thick, occupying about one half of the total thickness of the sterile part. It is composed throughout of rounded or irregularly polygonal cells with thin walls. Those at the surface are rather large, measuring 15–30 μ in diameter. Toward the inner side they become gradually smaller and grade off into the coarse, loosely interwoven hyphae of which the hypothecium is composed.

GALACTINIA SUCCOSA Berk.

The Galactinias are fleshy, cup-shaped, and sessile, but have the peculiarity of exuding a milky juice when wounded. In the present species the hypothecium is composed of rather large, loosely interwoven hyphae, which give rise on the upper side to the asci and paraphyses. The excipulum consists of two layers. The external one consists of large loosely interwoven hyphae forming a layer

which is quite easily separated from the inner one. The latter is pseudo-parenchymatous throughout, being formed of large, irreglar thin-walled cells 20–50 μ in diameter.

HUMARIA PURPURASCENS Pers.

The Humarias are small, sessile, fleshy plants, without external pili. They grow usually on the ground. The sterile layers of *H. purpurascens* occupy about one half the total thickness of the cup. They are pseudo-parenchymatous throughout, and made up of small, irregular, thin-walled cells, 8–15 μ in diameter. Those of the hypothecium are smaller and obscure.

BARLAEA CONSTELLATIO (B. & Br.) Sacc. Pl. 27, Fig. 1

The genus *Barlaea* differs from *Humaria* chiefly in possessing spherical spores.

In the present species the hypothecium is made up of very small pseudo-parenchymatous cells, measuring about 5 μ in diameter. They are closely packed together, so that their character is not easily made out. Grading off quite sharply from this layer is the excipulum composed of rounded thin-walled cells, measuring 6–10 μ in diameter. The character of these cells is quite uniform throughout all parts of the layer.

The genus OTIDEA. Pl. 28, Fig. 5

The Otideas are fleshy, subsessile plants, usually with bright colors. They are peculiar in that the apothecium is much elongated on one side, or vertically cleft or incised. They grow on the ground or on rotten wood.

Mr. G. Massee,* having made an examination of the British species of this genus, sums up the results of his study of the sterile layers in the following manner: *Otidea neglecta, leporina, apophysata, phlebophora* and *pleurota* "have the excipulum composed of densely interwoven hyaline hyphae, which become abruptly converted close to the outside into a more or less colored cortex, consisting of somewhat parallel septate hyphae, which sometimes cohere laterally, and form an approach to a parenchymatous tissue

* Massee (1), p. 67.

* * * A second type of structure is illustrated by *O. auricula*, and *O. micropus*, and consists of the excipulum being entirely parenchymatous, the cells very large and irregularly polygonal * * * Finally, *O. onotica* exhibits a type of structure exactly intermediate between the two previously described. The hypothecium and the broad cortical layer are truly parenchymatous, whilst a central zone consists of densely interwoven hyaline hyphae."

The only *Otidea* which I have examined is *O. leporina* and my observations differ only slightly from those of Massee. In my specimens the hypothecium and bulk of the excipulum are composed of coarse, closely interwoven, hyaline hyphae. These become abruptly converted into a truly pseudo-parenchymatous cortical layer composed of polygonal cells 25–40 μ in diameter. These show little traces of their hyphal origin. Occasionally little groups of these cells project slightly from the surface, giving it a granular or furfuraceous appearance.

PEZIZA BADIA Pers.

The genus *Peziza* includes the large cup-shaped, fleshy Discomycetes which are smooth and sessile. The structure of the sterile layers presents considerable variations in different species and we have all gradations from the coarse interwoven hyphae exhibiting various degrees of septation and coalescence to the pseudo-parenchyma of large vesiculose cells in some species 0.1 mm. in diameter.

A typical structure is seen in *Peziza badia* Pers. The hypothecium in this plant is very thin, and composed of very small and dense pseudo-parenchyma. The excipulum exhibits three well-marked layers. The ental one is entirely pseudo-parenchymatous, and is composed of large, rounded, thin-walled cells 50–75 μ in diameter. Intermingled with these are numerous smaller ones. The middle layer joins the ental one with an abrupt transition. Its thickness is about equal to that of the ental and ectal layers combined, and it is composed entirely of stout hyphae much bent and closely interwoven. The ectal layer resembles the ental one in being made up of rounded thin-walled cells. These become somewhat elongated toward the surface giving the latter a mealy or pruinose appearance.

MACROPODIA PUBIDA B. & C. Pl. 28, Fig. 3

The Macropodias are stipitate plants with hemispherical brown cups which are clothed externally with velvety brown pili. In *M. pubida* the sterile layers make up about one half of the total thickness of the apothecium, at least at the sides of the cup. The excipulum and hypothecium are quite well differentiated, and are of about equal thickness. The excipulum is composed of rather large pseudo-parenchymatous cells with thick walls which are elongated somewhat toward the outside of the cup. They measure 30–40 μ in length. The ental cells of the excipulum are smaller and nearly isodiametric, 8–10 μ in diameter. They grade off into the thin-walled cells of the hypothecium. The hairs which make up the pubescence are simply produced excipular cells.

The hypothecium is thick and composed of small cells, 8–10 μ long, which are more or less elongated in a direction parallel to the surface of the cup. The cells of the medullary region of the stem are of the same character as those of the hypothecium.

SARCOSCYPHA

In this genus are included several interesting and pretty species growing usually on dead wood. The cups are stipitate and bright-colored within, usually of some shade of orange or scarlet. They are clothed externally with floccose hairs.

S. OCCIDENTALIS (Schw.) Sacc.

The structure of this plant is strictly Pezizaceous. The hypothecium and excipulum are not well differentiated, but grade into each other. The whole medullary portion of the cup is made up of a pseudo-parenchyma, composed of small, somewhat elongated flexuose cells, 6–8 μ in diameter, which are united into a close compact tissue. At the surface, the cells are larger, fully 15–25 μ in diameter, and are compacted into a layer which continues upward so as to form the margin of the cup.

S. FLOCCOSA (Schw.) Sacc.

In this plant the hypothecium is confined to a very thin layer of closely interwoven threads just beneath the hymenium. The medullary portion of the stem is made up of very closely com-

pacted parallel threads running in a longitudinal direction. As the cup expands at the top of the stem these hyphae spread out in a radiating manner toward the margin. At the side of the hymenium they expand, forming a long and prominent margin to the cup. At this place they become thicker and looser, with frequent septa, thus forming a strongly pseudo-parenchymatous tissue, with cells 6–10 μ in diameter. The marginal pili are direct prolongations of these hyphal cells. At the surface of the cup these hyphae are replaced by a thin stratum of pseudo-parenchymatous cells, 5–6 μ in diameter.

S. COCCINEA (Scop.) Sacc. Pl. 28, Fig. 4

The hypothecium in this species cannot be well distinguished from the adjacent excipular tissues. The excipulum consists of two well-marked layers. The inner or medullary is very thick and is composed of long, rather slender, hyaline hyphae loosely interwoven. At the sides of the hymenium these become parallel and closely compacted, with frequent septa, thus forming a wide margin of cylindrical parenchymatous cells. This marginal tissue closely resembles that described for *S. floccosa* preceding.

The outer layer is composed of thin-walled pseudo-parenchymatous cells, 6 × 15–20 μ in diameter, which are elongated in a direction parallel to the surface of the cup. Aside from being different in form these ectal cells take a deeper stain than the medullary hyphae. This layer in some cases separates quite easily from the one within.

The structure of the medullary tissue of *Sarcoscypha coccinea* and *S. floccosa* suggests the prosenchyma found in the Helotiaceous plants. In 1893, Schröter * included the genus *Sarcoscypha* with part of *Macropodia* in the family Helotiaceae, remarking that it approaches closely to the genus *Peziza* (*Macropodia*), referring especially to *P. macropus*. But the gross characters of these plants, such as the size, form, and consistency of the cups associate them more closely with the Pezizas, and other writers, including Rehm †, have placed them among the Pezizaceous genera. It was difficult, therefore, before a study of the characters of the sterile layers was undertaken to believe that these forms should be consistently placed in different families.

† Rehm, p. 1070. * Schröter (1), p. 59.

In the structure of the excipulum, however, we find more conclusive evidence of the Pezizaceous relationship of the Sarcoscyphas and Macropodias. It will be noted from the descriptions of the sterile layers of *S. occidentalis*, *S. floccosa*, *S. coccinea* and *M. pubida* given above, that all have at least the outer layer of the excipulum pseudo-parenchymatous, while in the first and last species named the sterile parts are wholly so.

It should also be borne in mind in this connection, that tissue composed of stout interwoven hyphae, closely resembling that of *S. coccinea*, is not uncommon in undoubted Pezizaceous species. In several species of *Otidea*, for example, a large portion of the ental part of the excipulum consists of this tissue. *Otidea onotica* and *Discina Stephensoniana* each have a stratum of hyphal tissue lying between layers of large vesiculose cells. Even in *Peziza badia* a central zone of the excipulum is made up of stout, many-septate hyphae not very far removed in character from those found in *Sarcoscypha coccinea*.

It may be objected that the Sarcoscyphas are more or less leathery in their texture while the great majority of the Pezizaceae are fleshy and brittle. Certain of the species of *Otidea*, however, approach *S. coccinea* in texture. There seems to be little reason, therefore, for removing the species of *Sarcoscypha* from their long recognized position to associate them with forms with which they have no evident close relationship in either external form or internal structure.

LACHNEA. Pl. 27, Fig. 2

The Lachneas are sessile, usually bright-colored, fleshy Discomycetes, which are clothed externally with brown pili. The members of this genus may stand as typical of the family in nearly every way. The consistency is purely fleshy; the asci are large and cylindrical, opening by a lid at the apex; the paraphyses are well developed with clavate apices, and the sporidia are large.

In the structure of their sterile tissues, also, the species conform fully to the family type. The following species have been examined: *L. scutellata*, *L. hemispherica*, *L. setosa*, *L. umbrata* and *L. albo-spadicea*. These forms exhibit so little variation that one, *Lachnea scutellata*, will be described as typical of all. The hypo-

thecium and excipulum are quite easily distinguishable, although shading gradually into each other. The hypothecium is composed of small pseudo-parenchymatous cells, 7–12 μ long, with thin walls. Those immediately beneath the asci are somewhat rounded, but the remainder show an elongation in a radial direction. The layer fades out toward the margin of the cup.

The excipulum consists of larger thin-walled cells, 40–50 μ in diameter. At the base of the cup they are somewhat vesiculose, and the walls have a brownish shade, with a tendency toward becoming thickened. The excipulum is produced at the sides so as to form a distinct margin to the cup. The marginal cells are smaller and narrower, and somewhat elongated. The external hairs are simply prolonged, thick-walled excipular cells. The pili may arise from any part of the excipulum, but their origin is usually deep seated, often being well in toward the hypothecium.

Phaeopezia fuscocarpa (E. & H.) Sacc. differs from *Lachnea* only in its dark spores, and agrees with it in the whole structure of its sterile tissues, which are pseudo-parenchymatous throughout.

SARCOSPHAERA SEPULTA (Fries) Schroet.

The plants of this genus are first spherically closed and buried in the ground. Later they split in a lobulated manner, becoming cup-shaped. The sterile layers of *S. sepulta* are pseudo-parenchymatous throughout. The cells increase gradually and uniformly in size from the hymenium to the outer surface, where the cells are brownish and give rise to the pili.

NEOTTIELLA NIVEA Romell.

The genus *Neottiella* differs from *Lachnea* in having the external hairs pure white instead of brown. In *N. nivea* the whole sterile tissues are pseudo-parenchymatous throughout, except at the surface where they give place to one of coarse hyphae closely interwoven. The latter give rise to the hairs which are long, linear, and septate, with thin, white walls. The cells of the pseudo-parenchyma are rounded or polygonal, 15–30 μ in diameter, and thin walled.

SPHAEROSPORA CONFUSA Cooke

Sphaerospora differs from *Lachnea* in having spherical spores. *S. confusa* has a thick, pseudo-parenchymatous excipulum, com-

posed of large, polygonal, thin-walled cells. Those at the base are quite regular, 20–50 μ in diameter, the inner ones being slightly smaller. The hypothecium is also pseudo-parenchymatous, but the cells are quite small, being only about 10 μ in diameter.

Review of the Pezizaceae.—It will be noted from the foregoing descriptions that two types of tissue are found in the sterile layers of the Pezizaceae. In the first place there is the pseudo-parenchyma of rounded cells which show little trace of their hyphal origin. This tissue is the common one, occurring in a large proportion of the forms studied. Secondly, there is the tissue composed of coarse, loosely interwoven hyphae, usually much bent and septated. This is also a common form, and very frequently occurs associated with the first type. Very rarely is it the only form present. Between these two types we have all gradations even in the same plant.*

Family ASCOBOLACEAE

A thorough and comprehensive study of this group was published by Boudier in 1869. No other family of the Pezizineae, perhaps, has been treated in so thorough a manner. The writer found throughout the family a great uniformity in the structure of the sterile organs. He described a subhymenial layer composed of small cells closely compacted. Beneath is a stratum of pseudo-parenchyma formed generally of interlacing filaments and composed of oblong rounded cells. The surface is covered by a thin membrane.

LASIOBOLUS EQUINUS (Müll.) Karst. Pl. 29, Fig. 6

The plants of this species usually grow thickly crowded on cow dung in the spring. The cups are obconical, sessile, and orange-red, with the outer surface beset with long hyaline pili.

* *Pyronema omphalloides* Bull.—This genus was removed by Schröter [(2), p. 176] in 1894 from the Pezizaceae, and associated with three other small genera to form a new family, the Pyronemaceae.

I have not been able to obtain very satisfactory sections of this species from the material at hand. Enough, however, can be made out in them to make certain the pseudo-parenchymatous nature of the whole sterile portion. This may be seen also in the diagrammatic figure given by de Bary. The tissue is composed of small, polygonal, thin-walled cells, which become larger toward the base. Under the apothecium we find the layer of long, slender hyphae composing the subiculum.

The hypothecium is a thick layer composed of small rounded cells about 3 μ in diameter, very closely compacted and obscured by granules. Toward the base and sides of the cup this tissue passes into one composed of larger polygonal cells, 6–10 μ in diameter, making up the excipulum. The outer excipular cells give rise near the margin to the pili, which are much prolonged, thick-walled cells of this layer. In my sections the excipular cells continue fully to the surface without any limiting membrane. The cup is fixed at the base by hyphae continuous with the basal cells of the excipulum.

ASCOBOLUS FURFURACEUS Pers.

The structure of the sterile layers of this plant closely resembles that of the preceding. The cells are generally much larger, while one or two layers at the surface form a more or less distinct ectal membrane.

Family HELOTIACEAE

SCLEROTINIA PSEUDOTUBEROSA Rehm. Pl. 31, Fig. 11

This is a small plant with a long slender stem growing on acorns. The waxy cup is reddish-brown within, but greenish-brown without. The sterile part of the plant exhibits three well-defined areas. The subhymenial area, or hypothecium, is a thin layer of very slender, closely interwoven hyphae, perhaps 1–2 μ in diameter. In the center of the cup the layer is well defined, but toward the margin it is lost by becoming blended with the excipulum.

The excipulum is composed of two layers. The inner or medullary one fills the whole central part of the stem and cup. It is made of extremely slender interlacing hyphae, which are looser than those of the hypothecium. The tissue is lost as it approaches the margin of the cup. The outer layer of the excipulum closely resembles the hypothecium, and it is composed of intricately interwoven hyphae. It forms an ectal membrane of uniform thickness covering the whole outer part of the stem and cup, and makes up the margin of the latter.

CYATHICULA CORONATA (Bull.) De Not. Pl. 30, Fig. 7

This little plant is so characterized by the white setose teeth with which the margin of the cup is ornamented that it is not likely to be confused with any other.

The medullary portion of the stem is formed of a dense mass of hyphae, 2 μ in diameter, running longitudinally and closely compacted together. As the cup expands at the summit of the stem, these hyphae spread out toward the margin, filling the whole central portion of the cup. A thin subhymenial layer of this tissue, more closely compacted than the rest, is the hypothecium. The ectal hyphae, especially at the sides of the cup, are more closely interlaced, forming a denser stratum beneath the outer excipulum.

The ectal excipulum is a distinct uniform layer on the sides of the stem and cup. The loosely interwoven hyphae composing it extend obliquely outward from the medullary layer within. The surface hyphae are more closely interwoven. The margin, with the teeth characteristic of the genus, is formed by a direct upward prolongation of the ectal excipular threads.

CHLOROSPLENIUM AERUGINOSUM (Oed.) De Not. Pl. 30, Fig. 9

This plant may be known by the clear verdigris-green color of the stem and cup, and by the deep green color which the mycelium imparts to the wood on which it grows.

The hypothecial layer is thin and but little differentiated. The medullary portion is in all respects similar to that of the other Helotiaceous plants described, except that the outer hyphae are not the more compacted. In the ectal membranous excipulum the threads are a little less closely interwoven.

The green color so characteristic of this genus is due to green granules deposited in the excipulum. Scattered green granules occur throughout the layer, but at the surface they become so numerous as to obscure the hyphae. Irregular masses occur also on the surface, causing it to appear furfuraceous.

PHIALEA CYATHOIDEA (Bull.) Gill.

This little plant grows on decaying twigs and resembles a *Cyathicula* without teeth.

The sterile layers of this species resemble those of *Cyathicula coronata* so closely that a separate description is not necessary. Sections of the two plants could scarcely be distinguished but for the teeth. Various other species of *Phialea* examined have an essentially similar structure.

HELOTIUM CITRINUM (Hedw.) Fr. Pl. 30, Fig. 8

This is one of the commonest of the Discomycetes growing on rotton wood. The disc is a bright clear yellow.

This plant, too, resembles *Cyathicula* and *Phialea* in all essential particulars, as do *H. fagineum*, *H. fructigenum*, *H. virgultorum* and others.

HELOTIUM EPIPHYLLUM (Pers.) Fr. Pl. 31, Fig. 13

The hypothecium and medullary portion of this plant are essentially the same as those in plants previously described in this family. The ectal layer of the excipulum, however, differs very decidedly in being composed of small rounded cells 9–12 μ in diameter. These cells are thin-walled and hyaline, and form a definite pseudo-parenchymatous tissue. The layer fades out toward the margin, and in this respect, also, differs from all the plants previously described.

H. herbarum agrees in essential features with *H. epiphyllum*.

PITYA CUPRESSI (Batsch) Fuckel

Rehm* says of this plant: "Excipulum prosenchymatous." Massee† on the other hand gives: "Hypothecium and excipulum parenchymatous, cortical cells largest." My sections made from N. A. F. no. 2322 show the following structure: The hypothecium and medullary portion are prosenchymatous throughout. The innermost part is made up of closely interwoven slender hyphae occasionally septated. Toward the outside they become more parallel. The cortex or ectal layer of the excipulum is very different and is separated by an abrupt transition from the parts within. It is distinctly pseudo-parenchymatous, composed of rounded cells 9–15 μ in diameter. The walls are thin and hyaline.

* Rehm, p. 926.

† Massee (3), 4: 291.

LACHNELLA FLAMMEA (A. & S.) Fuckel

The plants of this species are small, sessile, nearly globose, and brick-red in color. The exterior is clothed with long, red-brown hairs.

The sterile layers of this plant are uniformly composed of slender, hyaline hyphae. At the surface many of the threads are produced into long, brown, septate pili.

LACHNUM VIRGINEUM (Batsch) Karst. Pl. 30, Fig. 10

This is a very common Discomycete growing on rotton wood. The whole plant is pure waxy white with a slender stem. The surface is clothed with white pili.

The hypothecium and medullary tissue are composed of very slender hyphae densely interwoven, thus conforming to the type described for *Cyathicula*. The ectal layer has the threads stouter and less closely interlaced. Toward the surface the hyphae become still looser and finally project as long slender hyaline pili, which are very prominent at the sides and margin of the cup.

LACHNUM SULFUREUM (Pers.) Rehm. Pl. 31, Fig. 12

The hypothecium and medullary part of the cup resemble the last species in being composed of slender, hyaline hyphae closely interwoven. The tissue extends to the margin where the threads project as slender pili. The ectal excipular layer is truly pseudo-parenchymatous, being made up of rounded cells 9–12 μ in diameter with thin, hyaline walls. This tissue extends from just below the margin down the sides of the cup to the stem-like base where it fades out.

ARACHNOPEZIZA AURELIA (Pers.) Fuckel

This is a pretty little species growing on leaves or rotton wood. The cups are sessile on a thin white subiculum, are golden-red in color, and clothed externally with reddish pili.

There seems to be some confusion regarding the structure and position of this plant. In its external characters it is clearly related to *Tapesia*. Fuckel, * however, founded the genus *Arachnopeziza* to include those forms which are seated on a subiculum, but which possess filiform spores. Saccardo † placed this as a subgenus

* Fuckel, p. 303.

† Saccardo (2), p. 499.

under *Belonidium* on account of the form of the spores. Rehm * and Schröter † included the genus in the Helotiaceae, making it comprehend those species which, on account of their *prosenchymatous* excipulum, are separated from the Mollisiaceous genus *Trichobelonium*.

My sections made from Ellis and Everhart's N. A. F. no. 59, show the following structure: The excipulum consists of two layers. The inner one made up of slender hyaline hyphae grades off into the thin hypothecium above. At the sides of the cup the threads are looser, and many of them project from the sides and margin as golden-brown pili. The ectal excipular layer is present only at the base of the cup, being lost as the sides begin to be elevated. It is pseudo-parenchymatous, the cells being thin-walled and hyaline. They are somewhat elongated and measure $15 \times 5\ \mu$.

OMBROPHILA

The plants of this genus are small with a gelatinous consistency. They usually have a short stem and grow on decaying vegetable matter in damp places. Most authors have included this genus with the next under the Bulgariaceae. Rehm ‡ followed the usual disposition but observed that in their structural characters these plants approach the Helotiaceous division of the Pezizineae. Schröter § went a step further and united the most of Rehm's Bulgarieae to the family Helotiaceae under a gelatinous division.

O. aurea, *O. purpurascens*, and *O. violacea* have been examined, and in all the whole sterile tissues are composed of very slender, hyaline hyphae closely interwoven.

CORYNE URNALIS (Nyl.) Sacc.

This is a reddish-purple, gelatinous plant growing on rotten wood. It differs from the preceding genus in being larger, and in having septate spores.

The hypothecium and medullary portion are composed of very slender hyaline hyphae like those in *Ombrophila*. The ectal layer

* Rehm, p. 698.
† Schröter (1), p. 68, (2), p. 200.
‡ Rehm, p. 467.
§ Schröter (1), p. 98; (2), p. 208 et seq.

of the excipulum, however, is different, being composed of rounded, thin-walled, hyaline cells, 10–15 μ in diameter.

Review of the Helotiaceae.—It will be noted that in all the Helotiaceous plants described above the principal tissue is a prosenchyma composed of long-drawn-out, slender hyaline hyphae closely interwoven. In the greater number, especially of the stipitate forms, it is the only tissue present. In all, it fills the medullary part of the stem and cup. In a few forms there is a cortical layer of pseudo-parenchyma but in the family as a whole this tissue is comparatively rare. It seldom if ever forms the margin of the cup, but is confined to the surface of the sides and base. There is also a sharp line of demarcation between such tissue and the prosenchyma, and rarely can one detect the much septated and coalesced hyphae showing a transition to the cellular structure, such as is commonly seen in the Pezizaceae. The tissue, too, whether it be hyphal or cellular is always hyaline and thin-walled.

The hyphae in this family are very different in character from those found in the Pezizaceae. · Here they are always very slender, long-drawn-out, but little branched, and infrequently septated. In the Pezizaceae they are stout, strongly curved, branched, and usually much septated. In the majority of cases in the Helotiaceae the ectal excipular layer forms a sort of cortical membrane covering the surface of the cup.

Family MOLLISIACEAE

MOLLISIA CINEREA (Batsch) Karst. Pl. 32, Fig. 14

This is a very common little Discomycete growing on rotten wood, especially in the spring. The cups are sessile and soft-waxy, with a cinereous disc.

The excipulum consists of two layers. The inner one with the hypothecium fills the medullary portion of the cup beneath the hymenium and extends upward to form the margin. It is composed of very delicate, hyaline hyphae. At the base and side of the cup, this gives place to a pseudo-parenchymatous outer excipular layer composed of rounded cells, 9–12 μ in diameter. The walls of the innermost cells are hyaline, but those near the surface

are thickened and dark brown. *M. polygoni* and *M. atrata* agree with the species just described, except that the brown outer layer of the excipulum is thicker and forms the margin of the cup.

TAPESIA FUSCA (Pers.) Fuckel. Pl. 32, Fig. 15

In many respects this plant resembles *Mollisia cinerea*, but differs in being seated on a dark brown subiculum.

The hypothecium is poorly developed. The excipulum consists of two layers. The inner one is made up of small hyaline hyphae closely interwoven. The outer layer is composed of rounded or polygonal cells 9–12 μ in diameter. At the surface these cells have thick dark brown walls and are quite prominent, while the inner ones are hyaline and thin-walled.

The underlying subiculum consists of a layer of stout, loosely interwoven, brown hyphae, extending for some distance beyond the base of the cup on all sides. Many of these threads are continuous with the excipular cells at the base. *T. culcitella* (C. & E.) Sacc. differs in having the brown excipulum a little less extensive.

PSEUDOPEZIZA TRIFOLII (Bernh.) Fuckel

This plant is parasitic on the leaves of clover. The yellowish cups are at first buried beneath the epidermis, but finally break through, becoming sessile on the surface.

The excipulum is a single layer of rounded, brown-walled cells, 5–10 μ in diameter. At the base they are produced downward between the cells of the host. Occasionally those at the sides of the cup are prolonged from the surface in the form of very short pili. The hypothecium is thin.

PYRENOPEZIZA EBULI (Fr.) Sacc.

This is a small, sessile, black plant growing on herbaceous stems. It develops under the epidermis but finally breaks through, becoming cup-shaped.

The excipulum consists of two layers. The thick outer one is composed at the base of rounded or somewhat elongated cells, 5 μ in diameter, with brown walls. At the sides of the cup the cells are larger and more uniformly rounded, 9–12 μ in diameter. At the margin they become elongated and fibrous.

The inner excipular layer is made up of long, slender, hyaline threads which continue upward to form the inner part of the margin. The hypothecium is thin and obscure.

BELONIELLA DEHNII (Rab.) Sacc. Pl. 32, Fig. 17

This plant is parasitic on the stem and petioles of *Potentilla*

As in other Mollisiaceous plants, the hypothecium is little prominent. The excipulum resembles that of *Pseudopeziza trifolii*. It is made up of polygonal cells, 10–12 μ in diameter. The innermost cells have thin, hyaline walls, but toward the surface they become thicker and dark brown in color. The excipular tissue is continuous at the base with the intercellular nutritive mycelium.

ORBILIA VINOSA (A. & S.) Karst. Pl. 32, Fig. 16

The plants of this species are small and gelatinous, becoming contorted when dry. The cups are sessile, smooth, with a clear wine-purple color. The species represents a group which was formerly placed in the Bulgariaceae. Rehm,* however, suggested that on the basis of excipular structure they approach mostly the division Mollisiaceae, and should, perhaps, be united wholly with it. Schröter † there foreunited the most of Rehm's Callorieae to the Mollisiaceae, in the same way that he did the Bulgarieae to the Helotiaceae.

In *Orbilia vinosa* the hypothecium is poorly developed. The excipulum has two layers. The inner one is composed of fine, closely interwoven hyphae. The outer layer consists of isodiametric cells, 9–12 μ in diameter with thin walls. It forms a stratum three to five cells thick over the whole exterior of the cup.

Review of the Mollisiaceae.—It will be seen that both prosenchyma and pseudo-parenchyma are found in this family. The former tissue when it occurs resembles that of the Helotiaceae. The latter is always present and forms the principal sterile tissue in the family. Except in the gelatinous group, the cells, at least the outer ones, have thick brown walls. This is a striking characteristic of all the Mollisiaceous plants. There seems to be no structural reason why *Orbilia* should not as well be united with the

* Rehm, p. 445.

† Schröter (1), p. 120; (2), p. 217.

Helotiaceae as with the Mollisiaceae. The general habit of the plants, however, seems to associate them rather with the latter group.

Conclusions.—1. It is possible to separate the fleshy Pezizineae into families of which the structure of the sterile layers of the cup offers important distinguishing characters.

2. Schröter's characterization of the Pezizaceae as having the hypothecium and excipulum composed of rounded cells is too general. Both cellular and hyphal tissues occur, but, as shown above, the structure of the latter is peculiar to this family.

3. Rehm's and Schröter's characterization of the Helotiaceae as having the excipulum prosenchymatous is also too general. This is the predominating tissue, but pseudo-parenchyma also occurs. Both kinds are, however, uniformly thin-walled and light colored.

4. The Mollisiaceae have the outer excipular layer pseudo-parenchymatous, the cells near the surface having thick dark brown walls.

5. On the basis of the preceding studies the families should be characterized as follows :

I. PEZIZACEAE

Plants usually of medium or large size. Apothecia free on the substratum, or rarely at first buried in the soil, fleshy, brittle, or rarely leathery, sessile, or with a thick, fleshy stem, externally smooth or pruinose, tomentose or pilose ; at first nearly or quite closed, later more or less cupulate, concave or plane. Hypothecium usually well developed, formed of rounded cells, or of stout, septate hyphae. Excipulum pseudo-parenchymatous, or formed of stout hyphae much bent and branched, septated and coalesced, showing a transition to pseudo-parenchyma. Asci cylindrical or clavate, not projecting above the hymenium, opening mostly by a lid at the apex. Spores spherical to fusoid, commonly large and one-celled. Paraphyses filiform, usually thickened at the apex.

II. ASCOBOLACEAE

Plants of small or minute size, usually growing on dung. Apothecia free on the substratum, fleshy or rarely somewhat waxy

or gelatinous, sessile, externally smooth, granular, or pilose; at first closed, later concave, finally plane or discoid. Hypothecium and excipulum uniformly pseudo-parenchymatous, composed of rounded cells. Asci cylindrical or clavate, at maturity projecting far above the hymenium, causing it to appear papillose, usually opening by a lid. Spores spherical, elliptical or fusiform, continuous, hyaline or colored, eight or more in an ascus.

III. HELOTIACEAE

Plants usually of small size. Apothecia free on the substratum, waxy, membranous, rarely leathery or gelatinous, sessile or stipitate, externally smooth or hairy; at first closed, later becoming cupulate, concave or plane. Hypothecium and excipulum usually prosenchymatous, composed of slender, long-drawn-out hyphae, but little septated, rarely pseudo-parenchymatous, formed of thin-walled, hyaline cells. Asci cylindircal or clavate, opening mostly by a pore at the apex. Spores usually small, spherical to filiform, continuous or septate, hyaline. Paraphyses filiform or acerose.

IV. MOLLISIACEAE

Plants of small size. Apothecia free on the substratum, or at first buried, finally erumpent; waxy, fleshy-waxy, membranous or gelatinous, sessile or nearly so, usually smooth, rarely hairy. Cups at first closed, later becoming cupulate, concave or plane. Hypothecium little developed. Excipulum wholly or in part pseudo-parenchymatous, composed of rounded cells, the ectal ones having thick, brown walls. Asci cylindrical or clavate, opening mostly by a pore at the apex. Spores small, spherical to filiform, continuous or septate, hyaline. Paraphyses filiform, often thickened at the apex.

SYNOPSIS OF FAMILIES AND GENERA

In the following synopsis of genera, only those will be included which may be expected to occur in North America. Although the Discomycetes have been pretty thoroughly studied in certain portions of the county, yet in America as a whole the group is very little known. It is to be hoped that these plants may be less neglected in the future, so that our knowledge of the large number

of forms which probably occur may be somewhat more comprehensive.

A. Apothecia fleshy or rarely leathery. Tissue usually more or less pseudo-parenchymatous, or composed of coarse hyphae, much septated, and showing a transition to pseudo-parenchyma.
  B. Asci at maturity forming a uniform layer; plants usually of medium or large size. I. PEZIZACEAE.
  B. Asci at maturity projecting above the hymenium; plants of small size usually growing on dung. II. ASCOBOLACEAE.

A. Apothecia waxy, fleshy-waxy, gelatinous or membranous. Tissue usually at least partly prosenchymatous, formed of slender, long-drawn-out hyphae rarely septated, not showing a transition to pseudo-parenchyma.
  B. Excipulum usually prosenchymatous, rarely partly pseudo-parenchymatous, always hyaline. III. HELOTIACEAE.
  B. Excipulum wholly, or at least at the base, pseudo-parenchymatous, the outer cells with thick brown walls. IV. MOLLISIACEAE.

I. PEZIZACEAE.

A. Externally smooth or pruinose.
  B. Stipitate, distinctly cupulate.
    C. Externally venose-sulcate, stem stout. *Acetabula.*
    C. Externally even, stem slender or short. *Geopyxis.*
  B. Cups sessile or subsessile.
    C. Cups regular, not elongated or split on one side.
      D. Large, exceeding 1 cm.
        E. Distinctly cupulate, sessile.
          F. Exuding a colorless juice when wounded. *Peziza.*
          F. Exuding a milky juice. *Galactinia.*
        E. Plane or repand, sessile or subsessile.
          F. Spores elliptical. *Discina.*
          F. Spores spherical. *Detonia.*
      D. Small, rarely exceeding 1 cm.
        E. Subiculum none.
          F. Spores elliptical or fusiform. *Humaria.*
          F. Spores spherical. *Barlaea.*
        E. Seated on a subiculum. *Pyronema.*
    C. Cups elongated or split on one side.
      D. Spores elliptical. *Otidea.*
      D. Spores spherical. *Otidella.*

A. Externally hairy, strigose, setose or tomentose.
  B. Black strigose at the base, stipitate or sessile.
    C. Spores elliptical or fusiform. *Plectania.*
    C. Spores spherical. *Pseudoplectania.*
  B. Not black strigose at the base.
    C. Stipitate.
      D. Apothecia light-colored. *Sarcoscypha.*
      D. Apothecia brown. *Macropodia.*

C. Sessile.
D. Spores elliptical or fusiform.
E. Externally brown pilose or ciliate.
F. Sessile on the substratum, regular. *Lachnea.*
F. At first buried in the soil, finally splitting at the apex irregularly. *Sarcosphaera.*
E. Externally white pilose. *Neottiella.*
D. Spores spherical. *Sphaerospora.*

2. ASCOBOLACEAE.

A. Spores hyaline.
B. Spores spherical. *Cubonia.*
B. Spores elliptical or fusiform.
C. Spores more than eight in an ascus. *Ryparobius.*
C. Spores eight in each ascus.
D. Externally smooth. *Ascophanus.*
D. Externally pilose. *Lasiobolus.*
A. Spores colored.
B. Spores spherical. *Boudiera.*
B. Spores elliptical or fusiform.
C. Spores free in the ascus. *Ascobolus.*
C. Spores enclosed in a sack in the ascus. *Saccobolus.*

3. HELOTIACEAE.

A. Apothecia waxy, membranous or leathery.
B. Externally smooth. HELOTIEAE.
C. Sessile by a broad base. PEZIZEI LEAE.
D. Spores 1-celled. *Pezizella.*
D. Spores elliptical or fusiform, 2–4-celled. *Belonium.*
D. Spores filiform, ∞-celled. *Gorgoniceps.*
C. Stipitate, or at least narrowed to a slender base.
D. Spores spherical. *Pitya.*
D. Spores elliptical or fusiform, 1-celled.
E. Apothecia green. *Chlorosplenium.*
E. Apothecia not green.
F. Margin toothed. *Cyathicula.*
F. Margin even.
G. Not arising from a sclerotium.
H. Cup small, membranous, thin, usually collapsing when dry; stem slender. *Phialea.*
H. Cup small, waxy, thick, not collapsing when dry; stem thick. *Helotium.*
H. Cup large, waxy-leathery; stem long and slender. *Ciboria.*
G. Arising from a sclerotium. *Sclerotinia.*
D. Spores elliptical or fusiform, 2–4-celled.
E. Cups large, waxy-leathery; stem long and slender. *Rutstroemia.*
E. Cups small, waxy, or membranous; stem short. *Belonioscypha.*
D. Spores filiform, ∞-septate. *Pocillum.*

B. Externally hairy.	TRICHOPEZIZEAE.
C. On a subiculum.	
D. Spores 1-celled.	*Eriopeziza.*
D. Spores elongated, ∞-celled.	*Arachnopeziza.*
C. Without a subiculum.	
D. Spores spherical.	*Lachnellula.*
D. Spores elongated.	
E. Hymenium beset with dark hairs.	*Desmazierella.*
E. Hymenium smooth.	
F. Paraphyses filiform, obtuse.	
G. Excipulum thin, spores 1-celled.	*Dasyscypha.*
G. Excipulum thick, spores 2-celled.	*Lachnella.*
F. Paraphyses acute at the apex.	
G. Spores 1-celled.	*Lachnum.*
G. Spores ∞-celled.	*Erinella.*
A. Apothecia gelatinous, horny when dry.	
B. Spores 1-celled.	
C. Cups minute, urceolate.	*Stamnaria.*
C. Cups larger, cupulate or concave.	*Ombrophila.*
B. Spores several-celled.	*Coryne.*

4. MOLLISIACEAE.

A. Apothecia waxy, fleshy-waxy or membranous.	MOLLISIEAE.
B. Apothecia from the first free on the substratum.	EUMOLLISIEAE.
C. Seated on a subiculum.	
D. Spores 1-celled.	*Tapesia.*
D. Spores ∞-celled.	*Trichobelonium.*
C. Without a subiculum.	
D. Spores 1-celled.	
E. Spores spherical.	*Mollisiella.*
E. Spores elliptical or fusiform.	*Mollisia.*
D. Spores finally 2-celled.	*Niptera.*
D. Spores fusiform, 4-∞-celled.	*Belonidium.*
D. Spores filiform, ∞-celled.	*Belonopsis.*
B. Apothecia erumpent.	PYRENOPEZIZEAE.
C. Apothecia bright colored, only slightly erumpent.	
D. Spores 1-celled.	*Pseudopeziza.*
D. Spores ∞-celled.	*Fabraea.*
C. Apothecia dark colored, much erumpent.	
D. Spores 1-celled.	
E. Cups hairy without.	*Pirottaea.*
E. Cups smooth without.	*Pyrenopeziza.*
D. Spores ∞-celled.	*Beloniella.*
A. Apothecia gelatinous, horny when dry.	CALLORIEAE.
B. Spores 1-celled.	*Orbilia.*
B. Spores 2–4-celled.	*Calloria.*

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Explanation of Plates

The tissues here represented are all taken from median longitudial sections, and are drawn from the base or sides of the cup. The sketches were made with a camera lucida, but in the more intricate ones the detail was filled in free hand. A portion of a stage micrometer is sketched by each figure to indicate the magnification.

FIG. 1. *Barlaea Constellatio.*

FIG. 2. *Lachnea scutellata.*

FIG. 3. *Macropodia pubida.*

FIG. 4. *Sarcoscypha coccinea*, part of cup at the surface showing the tomentum, the outer excipular layer, and a portion of the medullary part.

FIG. 5. *Otidea leporina*, showing the pseudo-parenchyma at the surface, and hyphal tissue within.

FIG. 6. *Lasiobolus equinus*, section of the entire plant. The specimen was not quite mature so that the asci do not project above the hymenium.

FIG. 7. *Cyathicula coronata.*

FIG. 8. *Helotium citrinum.*

FIG. 9. *Chlorosplenium aeruginosum.*

FIG. 10. *Lachnum virgineum.*

FIG. 11. *Sclerotinia pseudotuberosa.*

FIG. 12. *Lachnum sulphureum.*

FIG. 13. *Helotium epiphyllum.*

FIG. 14. *Mollisia cinerea.*

FIG. 15. *Tapesia fusca.*

FIG. 16. *Orbilia vinosa.*

FIG. 17. *Beloniella Dehnii.*

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